General

Guideline Title

Spinal injury: assessment and initial management.

Bibliographic Source(s)

National Clinical Guideline Centre. Spinal injury: assessment and initial management. London (UK): National Institute for Health and Care Excellence (NICE); 2016 Feb 17. 23 p. (NICE guideline; no. 41).

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Recommendations

Major Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

The wording used in the recommendations in this guideline (for example, words such as 'offer' and 'consider') denotes the certainty with which the recommendation is made (the strength of the recommendation) and is defined at the end of the "Major Recommendations" field.

NICE has developed four related clinical guidelines and one service delivery guideline related to the management of people with traumatic injuries including this guideline on spinal injury assessment and initial management and the following guidelines:

- Fractures (complex): assessment and management
- Fractures (non-complex): assessment and management
- Major trauma: assessment and initial management
- Major trauma: service delivery

Recommendations below apply to both children (under 16s) and adults (16 or over) unless otherwise specified.

Assessment and Management in Pre-hospital Settings

Assessment for Spinal Injury

On arrival at the scene of the incident, use a prioritising sequence to assess people with suspected trauma, for example <C>ABCDE:

- Catastrophic haemorrhage
- Airway with in-line spinal immobilisation (for guidance on airway management refer to the NGC summary of the NICE guideline Major trauma: assessment and initial management)
- Breathing
- Circulation
- Disability (neurological)
- Exposure and environment

At all stages of the assessment:

- Protect the person's cervical spine with manual in-line spinal immobilisation, particularly during any airway intervention and
- Avoid moving the remainder of the spine

Assess the person for spinal injury, initially taking into account the factors listed below. Check if the person:

- Has any significant distracting injuries
- Is under the influence of drugs or alcohol
- Is confused or uncooperative
- Has a reduced level of consciousness
- Has any spinal pain
- Has any hand or foot weakness (motor assessment)
- Has altered or absent sensation in the hands or feet (sensory assessment)
- Has priapism (unconscious or exposed male)
- Has a history of past spinal problems, including previous spinal surgery or conditions that predispose to instability of the spine

Carry out full in-line spinal immobilisation if any of the factors in the recommendation above are present or if this assessment cannot be done.

Assessment for Cervical Spine Injury

Assess whether the person is at high, low or no risk for cervical spine injury using the Canadian C-spine rule as follows:

- The person is at high risk if they have at least one of the following high-risk factors:
  - Age 65 years or older
  - Dangerous mechanism of injury (fall from a height of greater than 1 metre or 5 steps, axial load to the head – for example diving, high-speed motor vehicle collision, rollover motor accident, ejection from a motor vehicle, accident involving motorised recreational vehicles, bicycle collision, horse riding accidents)
  - Paraesthesia in the upper or lower limbs
- The person is at low risk if they have at least one of the following low-risk factors:
  - Involved in a minor rear-end motor vehicle collision
  - Comfortable in a sitting position
  - Ambulatory at any time since the injury
  - No midline cervical spine tenderness
  - Delayed onset of neck pain
- The person remains at low risk if they are:
  - Unable to actively rotate their neck 45 degrees to the left and right (the range of the neck can only be assessed safely if the person is at low risk and there are no high-risk factors
- The person has no risk if they:
  - Have one of the above low-risk factors
  - Are able to actively rotate their neck 45 degrees to the left and right

Be aware that applying the Canadian C-spine rule to children is difficult and the child's developmental stage should be taken into account.

Assessment for Thoracic or Lumbosacral Spine Injury

Assess the person with suspected thoracic or lumbosacral spine injury using these factors:

- Age 65 years or older and reported pain in the thoracic or lumbosacral spine

- Dangerous mechanism of injury (fall from a height of greater than 3 metres, axial load to the head or base of the spine – for example falls landing on feet or buttocks, high-speed motor vehicle collision, rollover motor accident, lap belt restraint only, ejection from a motor vehicle, accident involving motorised recreational vehicles, bicycle collision, horse riding accidents)
- Pre-existing spinal pathology, or known or at risk of osteoporosis – for example steroid use
- Suspected spinal fracture in another region of the spine
- Abnormal neurological symptoms (paraesthesia or weakness or numbness)
- On examination:
    - Abnormal neurological signs (motor or sensory deficit)
    - New deformity or bony midline tenderness (on palpation)
    - Bony midline tenderness (on percussion)
    - Midline or spinal pain (on coughing)
- On mobilisation (sit, stand, step, assess walking): pain or abnormal neurological symptoms (stop if this occurs)

Be aware that assessing children with suspected thoracic or lumbosacral spine injury is difficult and the child's developmental stage should be taken into account.

When to Carry Out or Maintain Full In-line Spinal Immobilisation

Carry out or maintain full in-line spinal immobilisation if:

- A high-risk factor for cervical spine injury is identified and indicated by the Canadian C-spine rule
- A low-risk factor for cervical spine injury is identified and indicated by the Canadian C-spine rule and the person is unable to actively rotate their neck 45 degrees left and right
- Indicated by one or more of the factors listed in the recommendation above

Do not carry out or maintain full in-line spinal immobilisation in people if:

- They have low-risk factors for cervical spine injury as identified and indicated by the Canadian C-spine rule, are pain free and are able to actively rotate their neck 45 degrees left and right
- They do not have any of the factors listed in the recommendation above

How to Carry Out Full In-line Spinal Immobilisation

When immobilising the spine tailor the approach to the person's specific circumstances (see recommendations below).

The use of spinal immobilisation devices may be difficult (for example in people with short or wide necks, or people with a pre-existing deformity) and could be counterproductive (for example increasing pain, worsening neurological signs and symptoms). In uncooperative, agitated or distressed people, including children, think about letting them find a position where they are comfortable with manual in-line spinal immobilisation.

When carrying out full in-line spinal immobilisation in adults, manually stabilize the head with the spine in-line using the following stepwise approach:

- Fit an appropriately sized semi-rigid collar unless contraindicated by:
    - A compromised airway
    - Known spinal deformities, such as ankylosing spondylitis (in these cases keep the spine in the person's current position)
- Reassess the airway after applying the collar.
- Place and secure the person on a scoop stretcher.
- Secure the person with head blocks and tape, ideally in a vacuum mattress.

When carrying out full in-line spinal immobilisation in children, manually stabilise the head with the spine in-line using the stepwise approach in the recommendation above and consider:

- Involving family members and carers if appropriate
- Keeping infants in their car seat if possible
- Using a scoop stretcher with blanket rolls, vacuum mattress, vacuum limb splints or Kendrick extrication device

Extrication

When there is immediate threat to a person's life and rapid extrication is needed, make all efforts to limit spinal movement without delaying treatment.

Consider asking a person to self-extricate if they are not physically trapped and have none of the following:

- Significant distracting injuries
- Abnormal neurological symptoms (paraesthesia or weakness or numbness)
- Spinal pain
- High-risk factors for cervical spine injury as assessed by the Canadian C-spine rule

Explain to a person who is self-extricating that if they develop any spinal pain, numbness, tingling or weakness, they should stop moving and wait to be moved.

When a person has self-extricated:

- Ask them to lay supine on a stretcher positioned adjacent to the vehicle or incident.
- In the ambulance, use the recommendations above to assess them for spinal injury and manage their condition.

Do not transport people with suspected spinal injury on a longboard or any other extrication device. A longboard should only be used as an extrication device.

Pain Management in Pre-hospital and Hospital Settings

Pain Assessment

See the NICE guideline on patient experience in adult NHS services for advice on assessing pain in adults.

Assess pain regularly in people with spinal injury using a pain assessment scale suitable for the patient's age, developmental stage and cognitive function.

Continue to assess pain in hospital using the same pain assessment scale that was used in the pre-hospital setting.

Pain Relief

Offer medications to control pain in the acute phase after spinal injury.

For people with spinal injury use intravenous morphine as the first-line analgesic and adjust the dose as needed to achieve adequate pain relief.

If intravenous access has not been established, consider the intranasal[1] route for atomised delivery of diamorphine or ketamine.

Consider ketamine in analgesic doses as a second-line agent.

[1]At the time of publication (February 2016), neither intranasal diamorphine nor intranasal ketamine had a UK marketing authorisation for this indication. The prescriber should follow relevant professional guidance, taking full responsibility for the decision. Informed consent should be obtained and documented. See the General Medical Council's Prescribing guidance: prescribing unlicensed medicines for further information.

Immediate Destination after Injury

Be aware that the optimal destination for patients with major trauma is usually a major trauma centre. In some locations or circumstances intermediate care in a trauma unit might be needed for urgent treatment, in line with agreed practice within the regional trauma network.

Suspected Spinal Cord Injury

Transport people with suspected acute traumatic spinal cord injury (with or without column injury), with full in-line spinal immobilisation, to a major trauma centre irrespective of transfer time, unless the person needs an immediate lifesaving intervention.

Ensure that time spent at the scene is limited to giving life-saving interventions.

Divert to the nearest trauma unit if a patient with suspected acute traumatic spinal cord injury (with or without column injury), with full in-line spinal immobilisation, needs an immediate life-saving intervention, such as rapid sequence induction of anaesthesia and intubation, that cannot be delivered by the pre-hospital teams.

Do not transport people with suspected acute traumatic spinal cord injury (with or without column injury), with full in-line spinal immobilisation, directly to a spinal cord injury centre from the scene of the incident.

Suspected Spinal Column Injury

Transport adults with suspected spinal column injury without suspected acute traumatic spinal cord injury, with full in-line spinal immobilisation, to the nearest trauma unit, unless there are pre-hospital triage indications to transport them directly to a major trauma centre.

Transport children with suspected spinal column injury (with or without spinal cord injury) to a major trauma centre.

Emergency Department Assessment and Management

On arrival at the emergency department use a prioritising sequence for assessing people with suspected trauma (see recommendation under "Assessment for Spinal Injury" above).

Protect the person's cervical spine as in the recommendation under "Assessment for Spinal Injury" above or maintain full in-line spinal immobilisation.

Assess the person for spinal injury as in the recommendation under "Assessment for Spinal Injury" above.

Carry out or maintain full in-line spinal immobilisation in the emergency department if any of the factors in the recommendation under "Assessment for Spinal Injury" above are present or if this assessment cannot be done.

Suspected Cervical Spine Injury

Assess the person with suspected cervical spine injury using the Canadian C-spine rule (see recommendation under "Assessment for Cervical Spine Injury" above).

Suspected Thoracic or Lumbosacral Spine Injury

Assess the person with suspected thoracic or lumbosacral spine injury using the factors listed in the recommendations under "Assessment for Thoracic or Lumbosacral Spine Injury" above.

When to Carry Out or Maintain Full In-line Spinal Immobilisation and Request Imaging

Carry out or maintain full in-line spinal immobilisation and request imaging if:

- A high-risk factor for cervical spine injury is identified and indicated by the Canadian C-spine rule or
- A low-risk factor for cervical spine injury is identified and indicated by the Canadian C-spine rule and the person is unable to actively rotate their neck 45 degrees left and right or
- Indicated by one or more of the factors listed in the recommendation under "Assessment for Thoracic or Lumbosacral Spine Injury" above

Do not carry out or maintain full in-line spinal immobilisation or request imaging for people if:

- They have low-risk factors for cervical spine injury as identified and indicated by the Canadian C-spine rule, are pain free and are able to actively rotate their neck 45 degrees left and right
- They do not have any of the factors listed in the recommendation under "Assessment for Thoracic or Lumbosacral Spine Injury" above

How to Carry Out Full In-line Spinal Immobilisation

When carrying out or maintaining full in-line immobilisation refer to the recommendations under "How to Carry Out Full In-line Spinal Immobilisation" above.

Diagnostic Imaging

Imaging for spinal injury should be performed urgently, and the images should be interpreted immediately by a healthcare professional with training and skills in this area.

Suspected Spinal Cord or Cervical Column Injury

Children

Perform magnetic resonance imaging (MRI) for children (under 16s) if there is a strong suspicion of:

- Cervical spinal cord injury as indicated by the Canadian C-spine rule and by clinical assessment or
- Cervical spinal column injury as indicated by clinical assessment or abnormal neurological signs or symptoms, or both

Consider plain X-rays in children (under 16s) who do not fulfil the criteria for MRI in the previous recommendation but clinical suspicion remains after repeated clinical assessment.

Discuss the findings of the plain X-rays with a consultant radiologist and perform further imaging if needed.

For imaging in children (under 16s) with head injury and suspected cervical spine injury, follow the recommendations in the NGC summary of the NICE guideline Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults.

Adults

Perform computed tomography (CT) in adults (16 or over) if:

- Imaging for cervical spine injury is indicated by the Canadian C-spine rule (see recommendation under "When to Carry Out or Maintain Full In-line Spinal Immobilisation and Request Imaging" above) or
- There is a strong suspicion of thoracic or lumbosacral spine injury associated with abnormal neurological signs or symptoms

If, after CT, there is a neurological abnormality which could be attributable to spinal cord injury, perform MRI.

For imaging in adults (16 or over) with head injury and suspected cervical spine injury, follow the recommendations in the NGC summary of the NICE guideline Head injury. Triage, assessment, investigation and early management of head injury in children, young people and adults.

Suspected Thoracic or Lumbosacral Column Injury Only (Children and Adults)

Perform an X-ray as the first-line investigation for people with suspected spinal column injury without abnormal neurological signs or symptoms in the thoracic or lumbosacral regions (T1–L3).

Perform CT if the X-ray is abnormal or there are clinical signs or symptoms of a spinal column injury.

If a new spinal column fracture is confirmed, image the rest of the spinal column.

Whole-Body CT

Use whole-body CT (consisting of a vertex-to-toes scanogram followed by CT from vertex to mid-thigh) in adults (16 or over) with blunt major trauma and suspected multiple injuries. Patients should not be repositioned during whole-body CT.

Use clinical findings and the scanogram to direct CT of the limbs in adults (16 or over) with limb trauma.

If a person with suspected spinal column injury has whole-body CT carry out multiplanar reformatting to show all of the thoracic and lumbosacral regions with sagittal and coronal reformats.

Do not routinely use whole-body CT to image children (under 16s). Use clinical judgement to limit CT to the body areas where assessment is needed.

Communication with Tertiary Services

For people in a trauma unit who have a spinal cord injury, the trauma team leader should immediately contact the specialist neurosurgical or spinal surgeon on call in the trauma unit or nearest major trauma centre.

For people in a major trauma centre who have a spinal cord injury, the trauma team leader should immediately contact the specialist neurosurgical or spinal surgeon on call.

For people who have a spinal cord injury, the specialist neurosurgical or spinal surgeon at the major trauma centre or trauma unit should contact the linked spinal cord injury centre consultant within 4 hours of diagnosis to establish a partnership of care.

All people who have a spinal cord injury should have a lifetime of personalized care that is guided by a spinal cord injury centre.

Early Management in the Emergency Department after Traumatic Spinal Cord Injury

All trauma networks should have network-wide written guidelines for the immediate management of a person with spinal cord injury and these should be agreed with the linked spinal cord injury centre.

The management of a spinal cord injury should be agreed between spinal surgery and spinal cord injury specialists for each person.

Do not use the following medications, aimed at providing neuroprotection and prevention of secondary deterioration, in the acute stage after acute traumatic spinal cord injury:

- Methylprednisolone
- Nimodipine
- Naloxone

Do not use medications in the acute stage after traumatic spinal cord injury to prevent neuropathic pain from developing in the chronic stage.

Information and Support for Patients, Family Members and Carers

The NGC summary of the NICE guideline Major trauma: service delivery contains recommendations for ambulance and hospital trust boards, senior managers and commissioners on information and support for patients, family members and carers.

Providing Support

When communicating with patients, family members and carers:

- Manage expectations and avoid misinformation
- Answer questions and provide information honestly, within the limits of your knowledge
- Do not speculate and avoid being overly optimistic or pessimistic when discussing information on further investigations, diagnosis or prognosis
- Ask if there are any other questions

The trauma team structure should include a clear point of contact for providing information to the patients, their family members and carers.

Make eye contact and be in the patient's eye line to ensure that you are visible when communicating with this person to avoid them moving their head.

If possible, ask the patient if they want someone (a family member, carer or friend) with them.

If the patient agrees, invite their family member, carer or friend into the resuscitation room.

Ensure that they are accompanied by a member of staff and their presence does not affect assessment, diagnosis or treatment.

Support for Children and Vulnerable Adults

Allocate a dedicated member of staff to contact the next of kin and provide support for unaccompanied children and vulnerable adults.

Contact the mental health team as soon as possible for patients who have a pre-existing psychological or psychiatric condition that might have contributed to their injury, or a mental health problem that might affect their wellbeing or care in hospital.

For a child or vulnerable adult with spinal injury, enable their family members and carers to remain within eyesight if appropriate.

Work with family members and carers of children and vulnerable adults to provide information and support. Take into account the age, developmental stage and cognitive function of the child or vulnerable adult.

Include siblings of an injured child when offering support to family members and carers.

Providing Information

Explain to patients, family members and carers what is wrong, what is happening and why it is happening. Provide:

- Information on known injuries
- Details of immediate investigations and treatment, and if possible include time schedules
- Information about expected outcomes of treatment, including time to returning to usual activities and the likelihood of permanent effects on quality of life, such as pain, loss of function or psychological effects

Provide information at each stage of management (including the results of imaging) in face-to-face consultations.

Document all key communications with patients, family members and carers about the management plan.

Providing Information about Transfer from an Emergency Department

For patients who are being transferred from an emergency department to another centre, provide verbal and written information that includes:

- The reason for the transfer
- The location of the receiving centre and the patient's destination within the receiving centre. Provide information on the linked spinal cord injury centre (in the case of cord injury) or the unit the patient will be transferred to (in the case of column injury or other injuries needing more immediate attention)
- The name and contact details of the person who was responsible for the patient's care at the receiving centre
- The name and contact details of the person who was responsible for the patient's care at the initial hospital

Documentation in Pre-hospital and Hospital Settings

The NGC summary of the NICE guideline Major trauma: service delivery contains recommendations for ambulance and hospital trust boards, senior managers and commissioners on documentation within trauma networks.

Recording Information in Pre-hospital Settings

Record the following in people with suspected spinal injury in pre-hospital settings:

- <C>ABCDE (catastrophic haemorrhage, airway with in-line spinal immobilisation, breathing, circulation, disability [neurological], exposure and environment)
- Spinal pain
- Motor function, for example hand or foot weakness
- Sensory function, for example altered or absent sensation in the hands or feet
- Priapism in an unconscious or exposed male

If possible, record information on whether the assessments show that the person's condition is improving or deteriorating.

Record pre-alert information using a structured system and include all of the following:

- The patient's age and sex
- Time of incident
- Mechanism of injury
- Injuries suspected
- Signs, including vital signs and Glasgow Coma Scale
- Treatment so far
- Estimated time of arrival at emergency department
- Special requirements
- The ambulance call sign, name of the person taking the call and time of call

Receiving Information in Hospital Settings

A senior nurse or trauma team leader in the emergency department should receive the pre-alert information, and determine the level of trauma team response according to agreed and written local guidelines.

The trauma team leader should be easily identifiable to receive the handover and the trauma team ready to receive the information.

The pre-hospital documentation, including the recorded pre-alert information, should be quickly available to the trauma team and placed in the patient's hospital notes.

Recording Information in Hospital Settings

Record the items listed in the recommendation above as a minimum, for the primary survey.

Record the secondary survey results, including a detailed neurological assessment and examination for any spinal pain or spinal tenderness.

If spinal cord injury is suspected in people aged over 4 years, complete an ASIA chart (American Spinal Injury Association) as soon as possible in the emergency department, and record:

- Vital capacity for people over 7 years
- Ability to cough

One member of the trauma team should be designated to record all trauma team findings and interventions as they occur (take 'contemporaneous notes').

The trauma team leader should be responsible for checking the information recorded to ensure that it is complete.

Sharing Information in Hospital Settings

Follow a structured process when handing over care within the emergency department (including shift changes) and to other departments. Ensure that the handover is documented.

Ensure that all patient documentation, including images and reports, goes with the patient when they are transferred to other departments or centres.

Produce a written summary, which gives the diagnosis, management plan and expected outcome and:

- Is aimed at and sent to the patient's general practitioner (GP) within 24 hours of admission
- Includes a summary written in plain English that is understandable by patients, family members and carers
- Is readily available in the patient's records

Training and Skills

These recommendations are for ambulance and hospital trust boards, medical directors and senior managers within trauma networks.

Ensure that each healthcare professional within the major trauma service has the training and skills to deliver, safely and effectively, the interventions they are required to give, in line with this guideline and the NGC summaries of the NICE guidelines Fractures (non-complex): assessment and management, Fractures (complex): assessment and management and Major trauma: assessment and initial management.

Enable each healthcare professional who delivers care to patients with trauma to have up-to-date training in the interventions they are required to give.

Provide education and training courses for healthcare professionals who deliver care to children with major trauma that include the following components:

- Safeguarding
- Taking into account the radiation risk of CT to children when discussing imaging for them
- The importance of the major trauma team, the roles of team members and the team leader, and working effectively in a major trauma team
- Managing the distress that families and carers may experience and breaking bad news the importance of clinical audit and case review

Definitions

Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Committee makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Committee is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

Interventions That Must (or Must Not) Be Used

The Guideline Committee usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally the Guideline Committee uses 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation

The Guideline Committee uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. The Guideline Committee uses similar forms of words (for example, 'Do not offer…') when confident that an intervention will not be of benefit for most patients.

Interventions That Could Be Used

The Guideline Committee uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost effective,

but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Clinical Algorithm(s)

A National Institute for Health and Care Excellence (NICE) pathway titled "Trauma overview" is provided on the NICE Web site .

Scope

Disease/Condition(s)

Spinal column or spinal cord injury

Guideline Category

Diagnosis

Evaluation

Management

Risk Assessment

Treatment

Clinical Specialty

Critical Care

Emergency Medicine

Internal Medicine

Neurological Surgery

Neurology

Orthopedic Surgery

Pediatrics

Radiology

Surgery

Intended Users

Advanced Practice Nurses

Emergency Medical Technicians/Paramedics

Health Care Providers

Hospitals

Nurses

Patients

Physician Assistants

Physicians

Guideline Objective(s)

To provide guideline recommendations on the assessment, imaging and early management of spinal injury

Target Population

All adults, young people, and children who present with suspected spinal column or spinal cord injury secondary to a traumatic event

Note: The guideline does not cover people whose injury is caused by disease rather than traumatic event.

Interventions and Practices Considered

1. Assessment and management in pre-hospital settings
    - Assessment for spinal injury using a prioritising sequence to assess people with suspected trauma (e.g., <C>ABCDE [catastrophic haemorrhage, airway with in-line spinal immobilisation, breathing, circulation, disability, exposure and environment])
    - Assessment for cervical spine injury using the Canadian C-spine rule
    - Assessment for thoracic or lumbosacral spine injury
    - Carrying out and maintaining full in-line spinal immobilisation
    - Extrication
2. Pain management in pre-hospital and hospital settings
    - Pain assessment using a suitable pain assessment scale
    - Pain relief (intravenous morphine or intranasal diamorphine or ketamine)
3. Immediate destination after injury
    - Transfer to major trauma centre or intermediate care in a trauma unit
    - Life-saving interventions
4. Emergency department assessment and management
    - Assessment for spinal, cervical spine, thoracic or lumbosacral spine injury
    - Carrying out and maintaining full in-line spinal immobilisation
5. Diagnostic imaging
    - Urgent imaging and immediate interpretation of images
    - Magnetic resonance imaging (MRI)
    - Plain X-rays
    - Computed tomography (CT)
    - Whole-body CT
6. Communication with tertiary services
    - Immediately contacting neurosurgical or spinal surgeon
    - Contacting the linked spinal cord injury centre consultant
7. Early management in the emergency department after traumatic spinal cord injury
    - Network-wide written guidelines for immediate management
    - Medications to avoid
8. Information and support for patients, family members and carers
    - Providing support for patients, family members and carers
    - Providing support for children and vulnerable adults
    - Providing information at each stage of management (including the results of imaging)
9. Documentation in pre-hospital and hospital setting
    - Recording information in pre-hospital settings

- Receiving and recording information in hospital settings
- Sharing information in hospital settings

10. Training and skills
    - Ensuring that healthcare professional within the trauma service have the training and skills to deliver interventions safely and effectively
    - Enabling healthcare professionals to have upâ€'toâ€'date training in all required interventions

Major Outcomes Considered

- Adverse effects associated with assessment, imaging, stabilisation and transfer
- Diagnostic accuracy (sensitivity and specificity)
- Complications of poor handling, poor resuscitation, and delayed bony stabilization
- Functional scales that quantify level of disability, such as the SCIM III
- Health-related quality of life
- Healthcare contacts; duration and continuity
- Return to normal activities
- Morbidity
- Mortality
- Patient-reported outcomes
- Cost-effectiveness

Methodology

Methods Used to Collect/Select the Evidence

Hand-searches of Published Literature (Primary Sources)

Hand-searches of Published Literature (Secondary Sources)

Searches of Electronic Databases

Description of Methods Used to Collect/Select the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

Developing the Review Questions and Outcomes

Review questions were developed in a PICO framework (patient, intervention, comparison and outcome) for intervention reviews. Review questions were developed with a framework of population, prognostic factor and outcomes for prognostic reviews, and with a framework of population, index tests, reference standard and target condition for reviews of diagnostic test accuracy. This was to guide the literature searching process, critical appraisal and synthesis of evidence, and to facilitate the development of recommendations by the Guideline Development Group (GDG). They were drafted by the NCGC technical team and refined and validated by the GDG. The questions were based on the key clinical areas identified in the scope (see Appendix A).

A total of 17 review questions were identified.

Full literature searches, critical appraisals and evidence reviews were completed for all the specified review questions.

Searching for Evidence

Clinical Literature Search

The aim of the literature search was to systematically identify all published clinical evidence relevant to the review questions. Searches were undertaken according to the parameters stipulated within the NICE Guidelines Manual (2012) (see the "Availability of Companion Documents"

field). Databases were searched using medical subject headings and free-text terms. Foreign language studies were not reviewed and, where possible, searches were restricted to articles published in the English language. All searches were conducted in MEDLINE, EMBASE, and the Cochrane Library, and were updated for the final time on 27th March 2015. No papers added to the databases after this date were considered.

Search strategies were quality assured by cross-checking reference lists of highly relevant papers, analysing search strategies in other systematic reviews, and asking GDG members to highlight any additional studies. The questions, the study types applied, the databases searched and the years covered can be found in Appendix F.

The titles and abstracts of records retrieved by the searches were sifted for relevance, with potentially significant publications obtained in full text. These were then assessed against the inclusion criteria.

Health Economic Literature Search

Systematic searches were undertaken to identify relevant health economic evidence within the published literature. The National Health Service Economic Evaluation Database (NHS EED), the Health Economic Evaluations Database (HEED) and Health Technology Assessment (HTA) database were searched using broad population terms and no date restrictions. A search was also run in MEDLINE and EMBASE using a specific economic filter with population terms. Where possible, searches were restricted to articles published in the English language. Economics search strategies are included in Appendix F. All searches were updated for the final time on 31st March 2015 except in HEED which ceased production in 2014. No papers added to the databases after this date were considered.

Evidence Gathering and Analysis

The tasks of the research fellow are listed below and described in further detail in the full version of the guideline. The research fellow:

- Identified potentially relevant studies for each review question from the relevant search results by reviewing titles and abstracts, and deciding which should be ordered as full papers. Full papers were then obtained.
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify studies that addressed the review question in the appropriate population and reported on outcomes of interest (see Appendix C for review protocols)

Inclusion and Exclusion Criteria

The inclusion and exclusion of studies was based on the criteria defined in the review protocols (see Appendix C). Excluded studies by review question (with the reasons for their exclusion) are listed in Appendix J. The GDG was consulted about any uncertainty regarding inclusion or exclusion. The key population inclusion criterion was:

- People of all ages experiencing an acute spinal injury (column and/or cord) as a result of a traumatic physical event

The key population exclusion criterion was:

- People with spinal injury directly resulting from a disease process, without any concomitant traumatic event

Conference abstracts were not automatically excluded from any review. No relevant conference abstracts were identified for this guideline. Literature reviews, posters, letters, editorials, comment articles, unpublished studies and studies not in English were excluded.

Type of Studies

Randomised trials, non-randomised trials, and observational studies (including diagnostic or prognostic studies) were included in the evidence reviews as appropriate.

For most intervention reviews in this guideline, randomised controlled trials (RCTs) were included because they are considered the most robust type of study design that could produce an unbiased estimate of the intervention effects. Crossover RCTs were appropriate for the question, 'What pre-hospital strategies to protect the spine in people with suspected traumatic spinal injury are the most clinically and cost effective during transfer from the scene of the incident to acute medical care?' If non-randomised studies were appropriate for inclusion, that is, non-drug trials with no randomised evidence, the GDG identified a priori in the protocol the variables which must either be equivalent at baseline or that the analysis had to adjust for any baseline differences. If the study did not fulfil either criterion it was excluded. Please refer to Appendix C for full details on the study design of studies selected for each review question.

For diagnostic reviews, diagnostic RCTs, cross-sectional and retrospective studies were included. For prognostic reviews, prospective and retrospective cohort studies were included. Case–control studies were not included.

Contacting Authors

If a study had inadequate information to permit a full evaluation of risk of bias, or had insufficient details on the outcomes, then the GDG had the option to request more information from the study's authors.

The GDG did not need to do this for any primary studies. However, the authors of a Cochrane systematic review were contacted in relation to the pharmacological interventions review. Additional data that had not been reported in either the original study papers or Cochrane review were obtained from the authors of the Cochrane review. This was done for the following outcomes:

- Sensory function at 6 weeks/6 months for the comparison of high-dose methylprednisolone and no treatment
- Motor function at 6 weeks for the comparison of high-dose methylprednisolone and no treatment
- Motor function at 1 year for the comparison of nimodipine versus no treatment
- Sensory function at 1 year for the comparison of nimodipine versus no treatment

In addition, data from five studies in the pharmacological interventions review were extracted from the Cochrane group systematic review. The original papers did not have these outcomes and the Cochrane group had contacted the study authors for the data.

Evidence of Cost-effectiveness

Evidence on cost-effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:

- Undertook a systematic review of the economic literature
- Undertook new cost-effectiveness analysis in priority areas

Literature Review

The health economist:

- Identified potentially relevant studies for each review question from the economic search results by reviewing titles and abstracts – full papers were then obtained
- Reviewed full papers against pre-specified inclusion/exclusion criteria to identify relevant studies (see below for details)

Inclusion and Exclusion

Full economic evaluations (studies comparing costs and health consequences of alternative courses of action: cost–utility, cost-effectiveness, cost-benefit and cost-consequence analyses) and comparative costing studies that addressed the review question in the relevant population were considered potentially applicable as economic evidence.

Studies that only reported cost per hospital (not per patient) or only reported average cost effectiveness without disaggregated costs and effects were excluded. Abstracts, posters, reviews, letters and editorials, foreign language publications and unpublished studies were excluded. Studies judged to have an applicability rating of 'not applicable' were excluded (this included studies that took the perspective of a non-Organisation for Economic Co-operation and Development [OECD] country).

Remaining studies were prioritised for inclusion based on their relative applicability to the development of this guideline and the study limitations. For example, if a high quality, directly applicable UK analysis was available other less relevant studies may not have been included. Where exclusions occurred on this basis, this is noted in the relevant section.

For more details about the assessment of applicability and methodological quality see the economic evaluation checklist (The Guidelines Manual, Appendix H) and the health economics research protocol in Appendix C in the full guideline appendices.

When no relevant economic analysis was found from the economic literature review, relevant UK NHS unit costs related to the compared interventions were presented to the GDG to inform the possible economic implication of the recommendation being made.

Number of Source Documents

See Appendix D: Clinical Article Selection and Appendix E: Economic Article Selection (see the "Availability of Companion Documents" field) for detailed flow charts on the article selection process, including total number of records identified through database searching, records screened, records excluded, full-text articles assessed for eligibility, studies included in review, and studies excluded from review.

Methods Used to Assess the Quality and Strength of the Evidence

Weighting According to a Rating Scheme (Scheme Given)

Rating Scheme for the Strength of the Evidence

Overall Quality of Outcome Evidence in Grading of Recommendations Assessment, Development and Evaluation (GRADE)

Level	Description
High	Further research is very unlikely to change confidence in the estimate of effect.
Moderate	Further research is likely to have an important impact on confidence in the estimate of effect and may change the estimate.
Low	Further research is very likely to have an important impact on confidence in the estimate of effect and is likely to change the estimate.
Very Low	Any estimate of effect is very uncertain.

Methods Used to Analyze the Evidence

Meta-Analysis

Review of Published Meta-Analyses

Systematic Review with Evidence Tables

Description of the Methods Used to Analyze the Evidence

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

Evidence Gathering and Analysis

The tasks of the research fellow are listed below and described in further detail in the full version of the guideline. The research fellow:

- Critically appraised relevant studies using the appropriate study design checklists as specified in The Guidelines Manual (NICE [2012]) (see the "Availability of Companion Documents" field).
- Critically appraised relevant studies with a qualitative study design NCGC checklist (see Appendix P).
- Extracted key information about interventional study methods and results using Evibase, NCGC purpose-built software. Evibase produces summary evidence tables, with critical appraisal ratings. Key information about non-interventional study methods and results were manually extracted onto standard evidence tables and critically appraised separately (see Appendix G for the evidence tables).
- Generated summaries of the evidence by outcome. Outcome data is combined, analysed and reported according to study design:
    - Randomised data is meta-analysed where appropriate and reported in Grading of Recommendations Assessment, Development and Evaluation (GRADE) profiles
    - Observational data is presented as a range of values in GRADE profiles
    - Diagnostic data is meta-analysed if appropriate or presented as a range of values in adapted GRADE profiles
    - Prognostic data is meta-analysed where appropriate and reported in GRADE profiles
    - Qualitative data is summarised across studies where appropriate and reported in themes
- A sample of a minimum of 20% of the abstract lists of the first three sifts by new reviewers were double sifted by a senior research fellow. As no papers were missed by any reviewers, no further double sifting was carried out. All of the evidence reviews were quality assured by a senior research fellow. This included checking:
    - Papers were included or excluded appropriately
    - A sample of the data extractions

- Correct methods were used to synthesis data
- A sample of the risk of bias assessments

Methods of Combining Evidence

Data Synthesis for Intervention Reviews

Where possible, meta-analyses were conducted to combine the data from the studies for each of the outcomes in the review question using RevMan5 software.

All analyses were stratified for age (under 18 years and 18 years or over), which meant that different studies with predominant age-groups in different age strata were not combined and analysed together. For some questions additional stratification was used, and this is documented in the individual question protocols (see Appendix C). If additional strata were used this led to sub-strata (for example, 2 stratification criteria would lead to 4 sub-strata categories, or 3 stratification criteria would lead to 9 sub-strata categories) which would be analysed separately.

See Section 4.3.4.1 of the full version of the guideline for details regarding analysis of different types of data including dichotomous outcomes, continuous outcomes, generic inverse variance, heterogeneity, and complex analysis/further analysis.

Data Synthesis for Diagnostic Test Accuracy Reviews
Two separate review protocols were produced to reflect the two different diagnostic study designs:

Diagnostic Randomised Controlled Trials (RCTs)

Diagnostic RCTs (sometimes referred to as test and treat trials) are a randomised comparison of two diagnostic tests, with study outcomes being clinically important consequences of diagnostic accuracy (patient outcomes similar to those in intervention trials, such as mortality). Patients are randomised to receive test A or test B, followed by identical therapeutic interventions based on the results of the test (that is, someone with a positive result would receive the same treatment regardless of whether they were diagnosed by test A or test B). Downstream patient outcomes are then compared between the two groups. As treatment is the same in both arms of the trial, any differences in patient outcomes will reflect the accuracy of the tests in correctly establishing who does and does not have the condition. Diagnostic RCTs were searched for first in preference to diagnostic accuracy studies (see below). Data were synthesised using the same methods for intervention reviews (see dichotomous or continuous outcomes in Section 4.3.4.1 of the full version of the guideline).

Diagnostic Accuracy Studies

For diagnostic test accuracy studies, a positive result on the index test was found in two different ways, according to whether the index test was measured on a continuous scale or was bivariate.

For continuous index test measures, a positive result on the index test was found if the patient had values of the chosen measured quantity above or below a threshold value, and different thresholds could be used. The threshold of a diagnostic test is defined as the value at which the test can best differentiate between those with and without the target condition and, in practice, it varies amongst studies. Diagnostic test accuracy measures used in the analysis were sensitivity and specificity, and, if different diagnostic thresholds were used within a single study, area under the receiver operating characteristics (ROC) curve.

For bivariate index test measures, a positive result on the index test was found if a particular clinical sign was detected. For example, a positive test would be recorded if a fracture was observed. Diagnostic test accuracy measures used in the analysis were sensitivity and specificity.

Coupled forest plots of sensitivity and specificity with their 95% confidence intervals (CIs) across studies (at various thresholds) were produced for each test, using RevMan5. In order to do this, 2x2 tables (the number of true positives, false positives, true negatives and false negatives) were directly taken from the study if given, or else were derived from raw data or calculated from the set of test accuracy statistics.

Diagnostic meta-analysis was conducted where appropriate; that is, when 5 or more studies were available per threshold. Test accuracy for the studies was pooled using the bivariate method modelled in Winbugs®. The bivariate method uses logistic regression on the true positives, true negatives, false positives and false negatives reported in the studies. Overall sensitivity and specificity and confidence regions were plotted. For scores with less than five studies, median sensitivity and the paired specificity were reported where possible. If an even number of studies were reported the lowest value of the two middle pairs was reported.

Heterogeneity or inconsistency amongst studies was visually inspected in the forest plots.

Data Synthesis for Risk Prediction Rules

Evidence reviews on risk prediction rules/tools results were presented separately for discrimination and calibration. The discrimination data was analysed according to the principles outlined under the section on data synthesis for diagnostic accuracy studies. Calibration data, such as R^2, if reported, were presented separately to the discrimination data. The results were presented for each study separately along with the quality rating for the study. Inconsistency and imprecision were not assessed.

Data Synthesis for Qualitative Reviews

For each included paper sub-themes were identified and linked to a generic theme. An example of a sub-theme identified by patients and carers is 'keeping an open channel of communication about reasons for any delays in the emergency room' and this is linked to a broader generic theme of 'information'. In some cases, sub-themes would relate to more than one generic theme. A summary evidence table of generic themes and underpinning sub-themes was then produced alongside the quality of the evidence.

Appraising the Quality of Evidence by Outcomes

Interventional Studies

The evidence for outcomes from the included RCT and observational studies were evaluated and presented using an adaptation of the 'Grading of Recommendations Assessment, Development and Evaluation (GRADE) toolbox' developed by the international GRADE working group . The software (GRADEpro) developed by the GRADE working group was used to assess the quality of each outcome, taking into account individual study quality and the meta-analysis results. Each outcome was first examined for each of the quality elements listed and defined in Table 2 in the full version of the guideline.

Overall Grading of the Quality of Clinical Evidence

Once an outcome had been appraised for the main quality elements, an overall quality grade was calculated for that outcome. The scores from each of the main quality elements (0, −1 or −2) were summed to give a score that could be anything from 0 (the best possible) to −8 (the worst possible). However, scores were capped at −3. This final score was then applied to the starting grade that had originally been applied to the outcome by default, based on study design. For example, all RCTs started as High and the overall quality became Moderate, Low or Very low if the overall score was −1, −2 or −3 points, respectively. The significance of these overall ratings is explained in the "Rating Scheme for the Strength of the Evidence" field. The reasons or criteria used for downgrading were specified in the footnotes of the GRADE tables. On the other hand, observational interventional studies started at Low, and so a score of −1 would be enough to take the grade to the lowest level of Very low. Observational studies could, however, be upgraded if there was: a large magnitude of effect, a dose-response gradient, and if all plausible confounding would reduce a demonstrated effect.

See Section 4.3.5.2 to 4.3.5.4 and Tables 5 to 7 in the full version of the guideline for additional details on grading of quality of evidence for prognostic and diagnostic studies and for qualitative reviews.

Assessing Clinical Importance

The Guideline Development Group (GDG) assessed the evidence by outcome in order to determine if there was, or potentially was, a clinically important benefit, a clinically important harm or no clinically important difference between interventions. To facilitate this, binary outcomes were converted into absolute risk differences (ARDs) using GRADEpro software: the median control group risk across studies was used to calculate the ARD and its 95% CI from the pooled risk ratio.

The assessment of clinical benefit, harm, or no benefit or harm was based on the point estimate of absolute effect for intervention studies which was standardised across the reviews. The GDG considered for most of the outcomes in the intervention reviews that if at least 100 participants per 1000 (10%) achieved (if positive) the outcome of interest in the intervention group compared with the comparison group then this intervention would be considered beneficial. The same point estimate but in the opposite direction would apply if the outcome was negative. For the critical outcomes of mortality, any reduction represented a clinical benefit. For adverse events, 50 events or more per thousand represented clinical harm. For continuous outcomes, if the mean difference was greater than the minimally important difference then this presented a clinical benefit or harm.

This assessment was carried out by the GDG for each critical outcome, and an evidence summary table was produced to compile the GDG's assessments of clinical importance per outcome, alongside the evidence quality and the uncertainty in the effect estimate (imprecision).

Clinical Evidence Statements

Clinical evidence statements are summary statements that are presented after the GRADE profiles, summarising the key features of the clinical effectiveness evidence presented. The wording of the evidence statements reflects the certainty/uncertainty in the estimate of effect. The evidence statements were presented by outcome and encompassed the following key features of the evidence:

- The number of studies and the number of participants for a particular outcome
- An indication of the direction of clinical importance (if one treatment is beneficial or harmful compared with the other or whether there is no difference between the two tested treatments)
- A description of the overall quality of evidence (GRADE overall quality)

Evidence of Cost-effectiveness

Evidence on cost-effectiveness related to the key clinical issues being addressed in the guideline was sought. The health economist:

- Undertook a systematic review of the economic literature
- Undertook new cost-effectiveness analysis in priority areas

Literature Review

The health economist:

- Critically appraised relevant studies using the economic evaluations checklist as specified in The Guidelines Manual
- Studies considered eligible but were excluded can be found in Appendix K.

Undertaking New Health Economic Analysis

As well as reviewing the published economic literature for each review question, as described above, new economic analysis was undertaken by the health economist in priority areas. Priority areas for new health economic analysis were agreed by the GDG after formation of the review questions and consideration of the available health economic evidence.

Additional data for the analysis was identified as required through additional literature searches undertaken by the health economist and discussion with the GDG. Model structure, inputs and assumptions were explained to and agreed by the GDG members during meetings, and they commented on subsequent revisions.

See Appendix L for details of the health economic analysis/analyses undertaken for the guideline.

Cost-effectiveness Criteria

NICE's report 'Social value judgements: principles for the development of NICE guidance' sets out the principles that GDGs should consider when judging whether an intervention offers good value for money.

In general, an intervention was considered to be cost effective if either of the following criteria applied (given that the estimate was considered plausible):

a. The intervention dominated other relevant strategies (that is, it was both less costly in terms of resource use and more clinically effective compared with all the other relevant alternative strategies), or
b. The intervention cost less than £20,000 per quality-adjusted life-year (QALY) gained compared with the next best strategy

If the GDG recommended an intervention that was estimated to cost more than £20,000 per QALY gained, or did not recommend one that was estimated to cost less than £20,000 per QALY gained, the reasons for this decision are discussed explicitly in the 'from evidence to recommendations' section of the relevant chapter with reference to issues regarding the plausibility of the estimate or to the factors set out in the 'Social value judgements: principles for the development of NICE guidance'.

In the Absence of Economic Evidence

When no relevant published studies were found, and a new analysis was not prioritised, the GDG made a qualitative judgement about cost-effectiveness by considering expected differences in resource use between options and relevant UK National Health Service (NHS) unit costs, alongside the results of the clinical review of effectiveness evidence.

The UK NHS costs reported in the guideline are those that were presented to the GDG and were correct at the time recommendations were drafted. They may have changed subsequently before the time of publication.

Methods Used to Formulate the Recommendations

Expert Consensus

Description of Methods Used to Formulate the Recommendations

Note from the National Guideline Clearinghouse (NGC): This guideline was developed by the National Clinical Guideline Centre (NCGC) on behalf of the National Institute for Health and Care Excellence (NICE). See the "Availability of Companion Documents" field for the full version of this guidance and related appendices.

Who Developed the Trauma Guidelines?

The four clinical guidelines and service delivery guidance consist of related topics with overlap in populations and key clinical areas for review. The guidelines have been developed together to avoid overlap and ensure consistency. This required careful planning to ensure the Guideline Development Groups (GDGs) had the support they needed. Senior clinical expertise was recruited in addition to the standard GDG.

Project Executive Team

The overlap in the content of the four clinical guidelines and the service delivery guidance required an approach that ensured coherence and avoided duplication across the guidelines. To address this, clinical experts from across the guidelines were recruited to form an umbrella group, the Project Executive Team (PET). The PET met quarterly throughout the development of the guidelines. At the PET meetings, the members provided expert advice to the technical team and GDG on the crossover of reviews across guidelines.

Guideline Development Group Expert Members

Expert members were healthcare professionals who worked across the four clinical guidelines and the service delivery guidance, and attended the GDGs that were relevant to their expertise. The expert members provided an additional level of coherence across the guidelines, helping to identify potential duplication in the areas of their expertise.

Guideline Development Group (GDG)

Each guideline 'stands alone' and addresses a specific area of care. A dedicated, multidisciplinary GDG, comprising health professionals, researchers and lay members developed this guidance.

The GDG was convened by the NCGC in accordance with guidance from NICE. The GDG met for two days every 6 weeks during the development of the guideline.

Staff from the NCGC provided methodological support and guidance for the development process. The technical team working on the guideline included a project manager, systematic reviewers, health economists and information scientists. The team undertook systematic searches of the literature, appraised the evidence, conducted meta-analysis and cost-effectiveness analysis where appropriate, and drafted the guideline in collaboration with the GDG.

Developing Recommendations

Over the course of the guideline development process, the GDG was presented with:

- Evidence tables of the clinical and economic evidence reviewed from the literature. All evidence tables are in Appendix G.
- Summary of clinical and economic evidence and quality as presented in Chapters 6-20 of the full version of the guideline.
- Forest plots and summary receiver-operating characteristic receiver operating characteristics (ROC) curves (see Appendix I).
- A description of the methods and results of the cost-effectiveness analysis undertaken for the guideline (see Appendix L)

Recommendations were drafted on the basis of the GDG interpretation of the available evidence, taking into account the balance of benefits, harms and costs. When clinical and economic evidence was of poor quality, conflicting or absent, the GDG drafted recommendations based on their expert opinion. The considerations for making consensus-based recommendations include the balance between potential harms and benefits, economic or clinical implications compared with the benefits, current practices, recommendations made in other relevant guidelines, patient preferences and equality issues. The consensus recommendations were done through discussions in the GDG. The GDG also considered whether the uncertainty was sufficient to justify delaying making a recommendation to await further research, taking into account the potential harm of failing to make a clear recommendation.

The main considerations specific to each recommendation are outlined in the Evidence to Recommendation Section preceding the recommendation section in the full version of the guideline.

Rating Scheme for the Strength of the Recommendations

Strength of Recommendations

Some recommendations can be made with more certainty than others. The Guideline Committee makes a recommendation based on the trade-off between the benefits and harms of an intervention, taking into account the quality of the underpinning evidence. For some interventions, the Guideline Committee is confident that, given the information it has looked at, most patients would choose the intervention. The wording used in the recommendations in this guideline denotes the certainty with which the recommendation is made (the strength of the recommendation).

Interventions That Must (or Must Not) Be Used

The Guideline Committee usually uses 'must' or 'must not' only if there is a legal duty to apply the recommendation. Occasionally the Guideline Committee uses 'must' (or 'must not') if the consequences of not following the recommendation could be extremely serious or potentially life threatening.

Interventions That Should (or Should Not) Be Used – a 'Strong' Recommendation

The Guideline Committee uses 'offer' (and similar words such as 'refer' or 'advise') when confident that, for the vast majority of patients, an intervention will do more good than harm, and be cost effective. The Guideline Committee uses similar forms of words (for example, 'Do not offer…') when confident that an intervention will not be of benefit for most patients.

Interventions That Could Be Used

The Guideline Committee uses 'consider' when confident that an intervention will do more good than harm for most patients, and be cost effective, but other options may be similarly cost effective. The choice of intervention, and whether or not to have the intervention at all, is more likely to depend on the patient's values and preferences than for a strong recommendation, and so the healthcare professional should spend more time considering and discussing the options with the patient.

Cost Analysis

Economic evidence is provided for each review question in the full version of the guideline (see the "Availability of Companion Documents" field).

See also the "Availability of Companion Documents" field for the following:

- Appendix L: Cost-effectiveness Analysis: Diagnosis of Traumatic Spinal Injury (see "Model Overview" below)
- Appendix M: Trauma Audit and Research Network (TARN) Immobilisation Costing (see description below)

Model Overview

A decision tree model was constructed to understand the economic implications and trade-offs given different assumptions regarding the accuracy of a diagnostic modality.

The model evaluates the clearance strategies available if a person is suspected of column injury, which may be a bony or ligamentous injury. There is clinical certainty that the optimal strategy to assess a person with suspected spinal cord injury (i.e., presenting with neurological signs) is with a magnetic resonance imaging (MRI) image, and this type of injury was not modelled further. The model is only applicable to adults due to the paucity of applicable evidence for children.

The model synthesizes the prevalence of spinal column injury and type of injury (bony or ligaments) with the accuracy of clinical decision rules and diagnostic imaging techniques. Patients directed to further imaging is dependent on the accuracy of the preceding diagnostic tool used. For example, a clinical decision rule may indicate x-ray for only a proportion of patients. Total diagnostic costs for each strategy are calculated according the proportion of patients who have been imaged.

For each strategy the number of patients correctly provided with treatment (true positives [TP]), provided with unnecessary clinical management (false positives [FP]), correctly and safely discharged (true negatives [TN]), and incorrectly left untreated (false negatives [FN]) is determined. Where injury is missed (FN), there is potential for deterioration and possibly conversion to cord injury. Note that the sensitivity of a test influences the number of true positives and false negatives, and the specificity of a test influences the number of true negatives and false positives identified.

Assigned to each outcome is a pay-off in regards to the patient's expected future health (quality-adjusted life year [QALY] gain) and initial and on-going treatment costs. Further, an additional cost of litigation due to missed injury is tested in a sensitivity analysis. The evidence on radiation risk in this population is absent; however, a sensitivity analysis tests the potential impact of radiation risk using indirect evidence.

The model estimates the number of people with a particular diagnostic outcome (i.e., missed injury), the overall cost of the strategy (in regards to diagnosis and treatment) and the potential QALY gain for a given strategy.

TARN Immobilisation Costing

Using data from the TARN database, the Guideline Development Group (GDG) has costed up the different combinations of spinal protection that were employed for all the patients that were identified in TARN as being immobilised in some form. This has been compared to the costs of using 'full immobilisation' on all these patients identified in TARN that had been potentially suspected of a spinal injury.

Criteria to Identify Patients Immobilised in TARN

All patients in TARN database in 2012 (January–December), excluding:

- Patients from foreign hospitals
- Patients classified as not TARN and
- The second record (receiving hospital after a transfer) from the matched cases

Patients with spinal injuries were selected using Hasler (2012) criteria, including those who had spinal fractures/dislocations (that is, fractures/dislocations of spinal vertebrae, pedicles, facets, laminae or the odontoid) or spinal cord injuries (that is, cord contusions and lacerations and incomplete and complete spinal cord syndromes). Those injured to the brachial plexus, traumatic disc injuries, fractures of the spinous and transverse processes, spinous ligament, nerve root injuries and strains of the spine were excluded.

Data and costings are tabulated in Appendix M of the full version of the guideline.

Method of Guideline Validation

External Peer Review

Internal Peer Review

Description of Method of Guideline Validation

Validation Process

The guidance is subject to an eight week public consultation and feedback as part of the quality assurance and peer review the document. All comments received from registered stakeholders are responded to in turn and posted on the National Institute for Health and Care Excellence (NICE) Web site when the pre-publication check of the full guideline occurs.

Evidence Supporting the Recommendations

Type of Evidence Supporting the Recommendations

Refer to the "Type of Studies" section in the "Description of Methods Used to Collect/Select the Evidence" field for a description of the studies that support the recommendations.

Benefits/Harms of Implementing the Guideline Recommendations

Potential Benefits

- Appropriate assessment, imaging and early management of spinal injury
- Reduced variation in pre-hospital spinal immobilisation strategies
- Improved immobilisation procedures
- Accurate assessment and documentation of the spinal injury

- Avoidance of secondary spinal cord injury in the presence of an unstable spinal column

See the "Trade-off between clinical benefits and harms" sections in the full version of the guideline (see the "Availability of Companion Documents" field) for benefits of specific interventions.

Potential Harms

- Routine stabilisation may subject many people to the potential of adverse events (such as discomfort or pressure sores) unnecessarily. Considering the balance between the potential for many to have minor adverse events with stabilisation, and the catastrophic and highly costly consequences of missed injury, the Guideline Development Group (GDG) felt that an over cautious but a selective approach was likely to be optimal.
- The GDG noted that despite the protective advantages of spinal immobilisation there are situations where a standard one-size-fits-all immobilisation approach could be harmful or delay treatment. Full in-line spinal immobilisation may impede management of the airway, on-going haemorrhage control and may worsen pre-existing conditions, such as ankylosing spondylitis. Collars may result in airway and/or respiratory compromise, and spinal boards can cause pain and prolonged use may lead to pressure sores.
- Computed tomography (CT) may carry a 100-fold greater radiation risk than X-ray, and thus, may not be appropriate for children or people who have been, or are likely to be, exposed to many scans (see Chapter 10 in the full version of the guideline [see the "Availability of Companion Documents" field] on the risks of radiations risks). Furthermore, despite CT's superiority over X-ray, it should be noted that the false-negative rate for CT was still unacceptably high for many column injuries.
- Missed diagnosis/injuries due to sensitivity/specificity of diagnostic tools
- Failure to pick up an unstable cervical column injury could lead to conversion to a spinal cord injury.
- The GDG felt that the benefits of reduced rates of moderate and severe neuropathic pain and mild depression could outweigh the low rates of relatively minor (nausea, vomiting and visual disturbance) adverse events reported for carbamazepine.

See the "Trade-off between clinical benefits and harms" sections in the full version of the guideline (see the "Availability of Companion Documents" field) for additional discussion of harms of specific interventions.

Contraindications

Contraindications

Semi-rigid collars are contraindicated by a compromised airway and known spinal deformities, such as ankylosing spondylitis (in these cases keep the spine in the person's current position).

Qualifying Statements

Qualifying Statements

- The recommendations in this guideline represent the view of National Institute for Health and Care Excellence (NICE), arrived at after careful consideration of the evidence available. When exercising their judgement, professionals are expected to take this guideline fully into account, alongside the individual needs, preferences and values of their patients or service users. The application of the recommendations in this guideline is not mandatory and the guideline does not override the responsibility of healthcare professionals to make decisions appropriate to the circumstances of the individual patient, in consultation with the patient and/or their carer or guardian.
- Local commissioners and/or providers have a responsibility to enable the guideline to be applied when individual health professionals and their patients or service users wish to use it. They should do so in the context of local and national priorities for funding and developing services, and in light of their duties to have due regard to the need to eliminate unlawful discrimination, to advance equality of opportunity and to reduce health inequalities. Nothing in this guideline should be interpreted in a way that would be inconsistent with compliance with those duties.

Implementation of the Guideline

Description of Implementation Strategy

An implementation strategy was not provided.

Implementation Tools

Clinical Algorithm

Foreign Language Translations

Mobile Device Resources

Patient Resources

Resources

Slide Presentation

For information about availability, see the *Availability of Companion Documents* and *Patient Resources* fields below.

Institute of Medicine (IOM) National Healthcare Quality Report Categories

IOM Care Need

Getting Better

IOM Domain

Effectiveness

Patient-centeredness

Timeliness

Identifying Information and Availability

Bibliographic Source(s)

National Clinical Guideline Centre. Spinal injury: assessment and initial management. London (UK): National Institute for Health and Care Excellence (NICE); 2016 Feb 17. 23 p. (NICE guideline; no. 41).

Adaptation

Not applicable: The guideline was not adapted from another source.

Date Released

2016 Feb 17

Guideline Developer(s)

National Clinical Guideline Centre - National Government Agency [Non-U.S.]

Source(s) of Funding

The National Clinical Guideline Centre (NCGC) was commissioned by the National Institute for Health and Care Excellence (NICE) to undertake the work on this guideline.

Guideline Committee

Guideline Development Group (GDG)

Composition of Group That Authored the Guideline

Guideline Development Group (GDG) Members: Jennifer Bostock, Patient member; Julie Buckley, Physiotherapy lead for Neuroscience intensive care, Wessex Neurological unit, Southampton General Hospital; Daniel Burden, Patient member; Cherylene Camps, Clinical team mentor, East Midlands Ambulance Service NHS Trust, HEMS Paramedic; Neil Chiverton, Consultant Orthopaedic Spinal Surgeon, Sheffield Teaching Hospitals NHS Foundation Trust; Brian Gardner, Consultant in Spinal Cord Injury; Paul Harrison, Clinical Development Officer, Princess Royal Spinal Cord Injuries Centre, Northern General Hospital, Sheffield; Debbie Hill, Senior lecturer in Physiotherapy, University of Hertfordshire and Honorary Research Associate, University College London; Anthony Hudson, Consultant in Emergency Medicine, St George's Hospital, London and Kent, Surrey and Sussex Air Ambulance Trust; Wagih El Masri, Clinical Professor of Spinal Injuries, Keele University and Emeritus Cons Surgeon in Spinal Injuries, RJAH Orthopaedic Hospital, Oswestry; Craig Morris, Consultant Intensivist and Anaesthetist, Royal Derby Hospital; David Skinner (*Chair*), Emeritus Consultant in Emergency Medicine, Oxford; Steve Smallwood, GP Partner, Southampton; Nick Todd, Consultant Neurosurgeon, Newcastle Nuffield Hospital

Financial Disclosures/Conflicts of Interest

At the start of the guideline development process all Guideline Development Group (GDG) members declared interests including consultancies, fee-paid work, share-holdings, fellowships and support from the healthcare industry. At all subsequent GDG meetings, members declared new and arising conflicts of interest.

Members were either required to withdraw completely, or for part of the discussion, if their declared interest made it appropriate. The details of declared interests and the actions taken are shown in Appendix B (see the "Availability of Companion Documents" field).

Guideline Status

This is the current release of the guideline.

This guideline meets NGC's 2013 (revised) inclusion criteria.

Guideline Availability

Available from the National Institute for Health and Care Excellence (NICE) Web site . Also available for download in ePub or eBook formats from the NICE Web site .

Availability of Companion Documents

The following are available:

- Spinal injury: assessment and initial management. Full guideline. London (UK): National Institute for Health and Care Excellence; 2016 Feb. 247 p. (NICE guideline; no. 41). Available from the National Institute for Health and Care Excellence (NICE) Web site .
- Spinal injury: assessment and initial management. Appendices. London (UK): National Institute for Health and Care Excellence; 2016 Feb. (NICE guideline; no. 41). Available from the NICE Web site .
- Spinal injury: assessment and initial management. Costing report. London (UK): National Institute for Health and Care Excellence; 2016 Feb. 13 p. Available from the NICE Web site .
- Spinal injury: assessment and initial management. Baseline assessment tool. London (UK): National Institute for Health and Care Excellence; 2016 Feb. (NICE guideline; no. 41). Available from the NICE Web site .
- Spinal injury: assessment and initial management. Slide set. London (UK): National Institute for Health and Care Excellence; 2016 Mar. 149 p. (NICE guideline; no. 41). Available from the NICE Web site .
- The guidelines manual 2012. London (UK): National Institute for Health and Care Excellence (NICE); 2012 Nov. Available from the NICE Web site .

Patient Resources

The following is available:

- Spinal injury: assessment and initial management. Information for the public. London (UK): National Institute for Health and Care Excellence; 2016 Feb. 8 p. (NICE guideline; no. 41). Available from the National Institute for Health and Care Excellence (NICE) Web site . Also available for download in eBook and ePub formats from the NICE Web site . Also available in Welsh from the NICE Web site .

Please note: This patient information is intended to provide health professionals with information to share with their patients to help them better understand their health and their diagnosed disorders. By providing access to this patient information, it is not the intention of NGC to provide specific medical advice for particular patients. Rather we urge patients and their representatives to review this material and then to consult with a licensed health professional for evaluation of treatment options suitable for them as well as for diagnosis and answers to their personal medical questions. This patient information has been derived and prepared from a guideline for health care professionals included on NGC by the authors or publishers of that original guideline. The patient information is not reviewed by NGC to establish whether or not it accurately reflects the original guideline's content.

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